

Title: “A Drop in the Bucket“ -- A Scientific and Mathematical Explanation of Water Conservation in the Home

Brief Overview:

The planet water availability is only 1% potable. How we use or abuse our water supply becomes critical to our very existence. This learning unit will permit students to become familiar with our water source, availability, costs, their own family usage, and the opportunity for wise usage through learned conservation techniques.

NCTM 2000 Principles for School Mathematics:

- **Equity:** *Excellence in mathematics education requires equity - high expectations and strong support for all students.*
- **Curriculum:** *A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades.*
- **Teaching:** *Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.*
- **Learning:** *Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.*
- **Assessment:** *Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.*
- **Technology:** *Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.*

Links to NCTM 2000 Standards:

• Content Standards

Algebra

Students will use mathematical models to analyze the change of water usage when water conservation methods are used.

Measurement

Students will determine the water flow from the bathroom tub faucet, shower head, sink, and from the kitchen sink and dishwasher.

Data Analysis and Probability

Students will develop a questionnaire to survey family members on their habitual water usage when: brushing teeth, showering, shaving, bathing, shampooing hair, washing dishes, washing clothes, etc. They will interpret data using a bar graph to evaluate water usage by comparing usage by members of those surveyed. Last of all, students will develop and evaluate a prediction of usage of the class members with and without water conservation techniques.

- **Process Standards**

Mathematics as Problem Solving, Reasoning and Proof, Communication, Connections, and Representation

These five process standards are threads that integrate throughout the unit, although they may not be specifically addressed in the unit. They emphasize the need to help students develop the processes that are the major means for doing mathematics, thinking about mathematics, understanding mathematics, and communicating mathematics.

Links to National Science Education Standards:

- **Unifying Concepts and Processes**

Students will provide evidence and explain the cost of water to their family during a one week period. They will develop a sense of the available potable water supply by researching the structure of the earth.

- **Science in Personal and Social Perspectives**

Students will discuss population growth and available sources for potable water.

Grade/Level:

Grades 7-8

Duration/Length:

Four days with one to two week follow up projects

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Estimating, rounding, and place value
- Calculating unit rates
- Adding and multiplying decimals
- Solving proportions

Student Outcomes:

Students will:

- collect, organize, graph, interpret, and analyze data.
- calculate the financial reward of water conservation
- develop and present findings to an audience of peers

Materials/Resources/Printed Materials:

- Student worksheet packet
- Teacher resource sheets

Development/Procedures:

Day 1

- Introduction: Explain that the class will start a week-long study of water conservation that will allow them to apply math skills to a real-world problem.

- Hand out “A Drop in the Bucket” packet and ask all students to fill out the “***Water Survey***”, Worksheet A.
- Conduct a whole class discussion of each question on the survey sheet. Teachers may consult ***Water Facts Information Sheet 1*** as necessary. Teachers also may include the ***Water Facts Information Sheet 1*** in the handout packet if they wish.
- Give a short “teacher talk” on water conservation based on the ***Water Facts Information Sheet 1***.
- Give an overview of the major project, “***Water Usage in My Home***”, Worksheet F but explain that you will have a more in depth discussion later.
- Assign “***Determining Water Usage***,” Worksheet B and “***You and Your Water Company***,” Worksheet C. Worksheet B must be completed as Day One’s homework. Worksheet C will be due on Day Three.

Day 2

- Divide the students into groups of four. Assign roles (facilitator, recorder, leader, and reporter). Explain their roles and responsibilities.
- Assign the students the task of developing the best method for measuring water flow based on their experiments from the previous night. Have the recorder write down the group’s ideas. Have the group reporters report on their findings.
- Hold a full class discussion on the first night’s techniques and results of measuring.
- Consult with the students on their progress with “***You and Your Water Company***,” Worksheet C. Have any students found water costs? Using student cost information (or \$.0025/gal as an example), ask students to independently calculate the costs of running a tap for five minutes based on an example of a tap rate flow provided by a student.
- Ask several students for their calculated costs and how they were calculated. Come to a consensus on how to calculate costs based on unit price, water flow and time. Provide more examples as necessary. Show how the exercise is a unit rate and proportion problem.
- Have students turn to “***Estimated Water Usage in the Home***,” Worksheet D and work independently on estimation, applying the consensus developed above. Help students as necessary until the Worksheet is completed.

Day 3

- Hold a group discussion on “***You and Your Water Company***,” Worksheet C.
- Have the students pair up to check each other’s calculations and compare estimations.
- During pair work, circulate around the class and see that students have completed all of the required worksheets. Give homework points for completion.
- Conduct a whole group discussion of how to calculate the “***Actual Water Usage in the Home***,” Worksheet E, using per person figures and adding the numbers of all members in each family. Discuss the results of the accumulated water costs.
- Discuss the long-term project, “***Water Usage in My Home***,” Worksheet F. Brainstorm difficulties students might encounter. Discuss possible solutions. (The main problem will likely be accurate water data collection.)
- Have the students write an explanation of how they will collect water data over the seven days for tonight’s assignment.

Day 4

- Divide the students into groups to share their water collection data ideas. Have students come to a consensus on the best plans. Have the recorder record the information.
- Have reporters share their groups’ plans and have students share any other concerns.
- Review the project. Discuss expectations using the Rubric Worksheets G, H and I.
- If necessary, review a bar graph’s construction. This may be an additional day.
- Have the students begin their project “***Water Usage in My Home***,” Worksheet F, as homework for this day.

One Week Later

- Check students' progress.
- Address concerns and questions.

Two Weeks Later

- Have students present and turn in their projects.
- Conduct a wrap-up discussion to summarize what students have learned.

Performance Assessment:

Student assessment will be based on the completion of the worksheets, the graphs, and the oral and written presentation using scoring rubrics included in the packet. This being a long-term project, assessments of each part may be weighted based on teacher judgment. (For example: all components 25% each or worksheet packet 20%, graphs 20%, oral presentation 25%, written presentation 35%)

Extension/Follow Up:

Some extension activities may include:

- Invite a speaker from the local water company to speak to the class.
- Extend the exploration to the rest of the student body, city, or the county.
- Present the learned information on water conservation to the community as part of a community outreach program.
- For those who live in an apartment complex where water is included in the rent, compose a letter to the Owner/Management Company inquiring whether they could decrease rent if using water conservation practices decreased water usage.
- Create a water conservation pamphlet to educate the school/city community.
- Calculate the school population water usage and savings by implementing water conservation practices school-wide.
- Coordinate extensions with the Science Department and/or Math Department from a neighboring school.

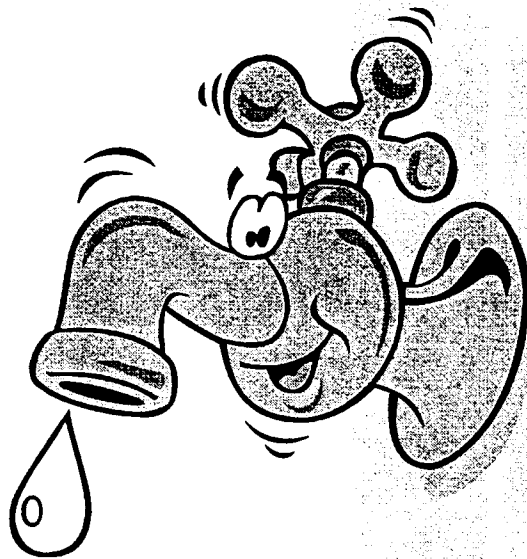
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A DROP IN THE BUCKET



WATER SURVEY

Worksheet A

1. List all the ways your family uses water. Include kitchen, laundry room and bathroom appliances, and plumbing fixtures. Consider, also, outdoor water use.
2. Which appliance do you think uses the most gallons of water?
3. Is water a free benefit of living in your community or must your parents pay for it?
4. If you think you must pay for water, how much do you think it costs per gallon? If you think it is a service provided by the community, how much do you think it costs the community per gallon?

5. Multiply your answer to number 5 by 30 and tell how many gallons you predict your family uses per month.

6. Multiply the predicted cost per gallon by the number of gallons you use per month. What is your predicted monthly water bill or the predicted cost to your community.

7. List at least five ways your family could decrease the amount of water used per month.

8. List the advantages, to your family and society, of conserving water usage.

DETERMINING WATER USAGE

Worksheet B

1. Describe what method you will use to determine the amount of water in gallons your various household faucets use per minute?

2. What materials will you use?

3. Using your method, determine the water flow rate for at least one sink faucet, one bathtub faucet, and one shower in your home. Record your information below:

Sink faucet:

Bathtub faucet:

Shower head:

YOU AND YOUR WATER COMPANY

Worksheet C

Using the Internet, phone book, phone calls, your parents' water bill, or any other resources available, please research and answer the following questions:

1. What Company sells your family water? *(If you live in an apartment or condominium, you may have to consult your landlord for this information)*
2. How frequently do you receive a water bill?
3. Per what unit of water used are you billed?
4. How does the Company know how much water you used?
5. How much does the Company charge you per unit of water used?
6. Is the rate always the same or does it vary?
7. If it varies, how does it vary and why do you think it varies?

ESTIMATED WATER USAGE IN THE HOME

Worksheet D

APPLIANCE OR FIXTURE	ESTIMATED USAGE UNITS (SEE BELOW)*	(UNITS) (USAGE RATE)	TOTAL ESTIMATED USAGE	(TOTAL COST) USE \$.0025 PER GALLON	ESTIMATED TOTAL COST
1. Kitchen faucet					
2. Bathroom faucets					
3. Shower faucet					
4. Bathtub faucet					
5. Toilets**					
6. Dishwasher**					
7. Washing machine**					
8. Other					
TOTALS					

* USAGE UNITS:

FAUCET - MINUTES OF USE
 TOILETS - NUMBER OF FLUSHES
 DISHWASHER - NUMBER OF LOADS
 WASHING MACHINE - NUMBER OF LOADS

** AVERAGE WATER USAGE RATES:

TOILET: 6 GALLONS/FLUSH
 DISHWASHER: 15 GALLONS/LOAD
 WASHING MACHINE: 40 GALLONS/LOAD

ACTUAL WATER USAGE IN THE HOME

Worksheet E

APPLIANCE OR FIXTURE	NUMBER OF USAGE UNITS (SEE BELOW)*	(UNITS) (USAGE RATE)	TOTAL USAGE IN GALLONS	(GALLONS) (COST)	TOTAL COST
1. Kitchen faucet					
2. Bathroom faucets					
3. Shower faucet					
4. Bathtub faucet					
5. Toilets**					
6. Dishwasher**					
7. Washing machine**					
8. Other					
TOTALS					

*** USAGE UNITS:**

FAUCET - MINUTES OF USE
 TOILETS - NUMBER OF FLUSHES
 DISHWASHER - NUMBER OF LOADS
 WASHING MACHINE - NUMBER OF LOADS

****AVERAGE WATER USAGE RATES:**

TOILET: 6 GALLONS/FLUSH
 DISHWASHER: 15 GALLONS/LOAD
 WASHING MACHINE: 40 GALLONS/LOAD

Water Usage in My Home

Worksheet F

- 1. Collect and record your family's usage of gallons of water for seven days. Use Worksheet D to record the totals for each of the seven weekly categories.**
- 2. Use your data to construct an attractive, multi-colored bar graph. The bar graph dimensions must be at least 8 1/2 by 11 inches. It must illustrate:**
 - a. the estimated use for each of the 7 categories.
 - b. the actual use for each of the 7 categories.
 - c. the total estimated use.
 - d. the total actual use.
 - e. the projected usage after adjusting for water-use behavior.
- 3. Analyze your bar graph.**
- 4. Write a paper to present and explain your data. Use the following Checklist to make sure you have included all of the information required.**

Checklist--Have you?

- ☐ Explained how your water usage is billed and projected how much your bill will be per month?
- ☐ Described how you collected your water data?
- ☐ Described how your estimated usage compared to your actual usage?
- ☐ Described ways you could limit water usage per month and estimated your usage and cost savings?
- ☐ Described benefits to your family and to society as a whole of conserving water usage at home?
- ☐ Typed your paper using 12 point type with double spacing?
- ☐ Written at least two full pages?
- ☐ Added a title, your name and date?
- ☐ Proof-read your paper?

5. Present your bar graph and data to the class. Use the following Presentation Checklist to make sure you meet all the requirement.

Presentation Checklist--Will you?

- ☐ Speak for five minutes?
- ☐ Describe your findings?
- ☐ Show your bar graph?
- ☐ Explain how you could decrease usage and cost?

Presentation Checklist--Have you?

- ☐ Practiced your presentation in front of family members or friends?

6. Turn in paper, worksheet packets and bar graph on _____.

RUBRIC FOR PACKET

Worksheet G

Worksheet A “Water Survey”

Response To Interpretive Questions	3	2	1	0
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Worksheet B “Determining Water Usage”

Accurate Information	3	2	1	0
Response To Interpretive Questions	3	2	1	0

Worksheet C “You and Your Water Company”

Response To Interpretive Questions	3	2	1	0
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Worksheet D “Estimated Water Usage in the Home”

Worksheet Completed	3	2	1	0
Information Accurate	3	2	1	0

Worksheet E “Actual Water Usage in the Home”

Worksheet Completed	3	2	1	0
Information Accurate	3	2	1	0

RUBRIC FOR BAR GRAPHS

Worksheet H

4

- Axes correctly labeled
- Title included
- Estimated, actual, and projected amount to be conserved included
- Size guidelines followed
- Neat

3

- Axes correctly labeled
- Title included
- Few data errors
- Neat

2

- Errors in labeling
- Many errors in data
- Work legible

1

- Effort shown
- Major errors found in labeling, data, and guidelines

RUBRIC FOR ORAL PRESENTATION

Worksheet I

4

- Student prepared and knowledgeable
- Findings on water usage and conservation fully described
- Ways student can decrease water usage and cost fully described
- Presented for 5 minutes

3

- Student fairly well prepared and knowledgeable
- Student's explanation fairly well done
- Student's description of how he/she can decrease water usage and cost is adequate

2

- Student somewhat prepared
- Explanation lacking all information

1

- Attempt at presenting information made, but student not prepared or knowledgeable of findings

RUBRIC FOR WRITTEN COMPONENT

Worksheet J

4

- Explanation of water usage and billing included
- Full description of how data was collected included
- Comparison of estimated and actual water usage included
- Ideas on ways water could be conserved with estimated cost savings explained
- Benefits of conserving water to family and society included
- Guidelines followed

3

- Most of the above included
- Explanations adequate
- Guidelines followed

2

- Few of the above included
- Explanations poor
- Some guidelines followed

1

- Minimal requirements met
- Guidelines not followed

WATER FACTS

Information Sheet 1

Water is essential to human life. The human race could not survive without it. It also is reinforced by the fact that humans use over 16,000 gallons of water during their lifetimes. This averages out to about 2.5 quarts per day. Although water is important to our lives, we waste and destroy this precious resource everyday. Through education, people can learn to preserve and conserve this resource on a day to day basis.

About 70% of the earth's surface is water. Clean, fresh water is essential to life. Most of the water you drink today has been around for billions of years. Is this water clean? Will there be enough water for another billion years? Where is all this water?

Do you know?

In some countries, people have to fetch their water from a spring or well. It's the women who do the fetching traditionally for water.

In Singapore, there is a fear that there will not be enough water for the growing population.

It costs over \$3.5 billion to operate water systems throughout the United States each year.

Ground water is water that sinks into the upper portion of the earth's surface.

It takes 39,090 gallons/148,000 liters of water to manufacture a new car and its 4 tires.

Americans drink more than 1 billion glasses of tap water each day.

On an average, 50%-70% of summer household water is used outdoors for watering gardens and lawns.

Only 1% of all our water is freely available fresh water; 97% is salty water in the sea and the remaining 2% is fresh water locked underground and in glaciers and polar ice caps.

Source: Waterfacts by Chad Shine and Rosa Juarez

WATER CONSERVATION

Information Sheet 2

LOW FLOW SHOWER

Older model shower heads use a lot of water. It is very easy to unscrew the shower head and replace it with a flow flow shower head. You take the same shower as you are used to, but much less water is used.

LEAKING TOILET

If you hear your toilet refilling by itself every few minutes, your toilet has a leak. The flapper valve needs to be replaced. You cannot see the water leaking out, but you can hear the toilet when it fills with water over and over.

LEAKING FAUCET

A leaking faucet is very annoying because you can hear the constant dripping in the sink. If you put the stopper in the sink, you can see how much water is being wasted by constant dripping. Changing the valve or a gasket in the handle will remedy the problem.

HOW MUCH DOES A LEAK WASTE IN OUR SINK?

A slow drip of water wastes 15 gallons of water per day. 1 leak wastes 25 gallons in 24 hours!!!! Think of all that water which could be put to good use.

Source: <http://public.csusm.edu...ervewaterbyfixingleaksyourself.html>

HOW MUCH WATER DO YOU USE?

Information Sheet 3

	Non-conserving	Conserving Activities
Shower (5 Minutes)	Regular shower head 30 gallons	Low-flow shower head 15 gallons Wet-down, rinse off 4 gallons
Toilet Flushing	Conventional toilet 5-7 gallons/flush	Ultra-low flush toilet 1.6 gallons Displacement bag 4-6 gallons
Brushing teeth	Tap running 10 gallons	Wet brush, rinse briefly Half a gallon or less
Tub Bath	Full 20 gallons	Minimal water level 20 gallons or less
Shaving	Tap running 20 gallons	Fill basin 1 gallon
Washing Hands	Tap running 2 gallons or more	Soap and Rinse 1 gallon or less
Dish washing	Tap running 30 gallons	Wash and rinse in sink 5 gallons
Automatic Dishwasher	Full Cycle 15 gallons	Short cycle 11 gallons
Washing Machine	Full cycle, top water level 40 gallons	New "tumble action" efficient clothes washer 25 gallons

Source: Marin Municipal Water District